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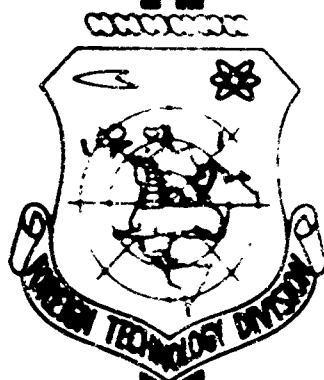
# TRANSLATION

FORMULA FOR REPRESENTING THE PRODUCT OF ORIGINALS

By

V. Ya. Matanov

## FOREIGN TECHNOLOGY DIVISION



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FORMULA FOR REPRESENTING THE PRODUCT OF ORIGINALS

BY: V. Ya. Matansoa

English Pages: 5

SOURCE: Prikladnaya Matematika i Mekhanika, Vol. 20, Nr. 9,  
1956, pp 671-672

S/OLO-056-020-009

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## FORMULA FOR REPRESENTING THE PRODUCT OF ORIGINALS

V. Ya. Matanov

(Moscow)

The derivation of a formula of the product of originals, as it is known, leans on the inversion formula. We shall show how one can obtain another formula of the product.

Let  $f(x) = \varphi(x)h(x)$ ,  $F(p) \div f(x)$  and

$$F(p) = p \int_0^{\infty} \varphi(t) h(t) e^{-pt} dt \quad (1)$$

We shall introduce the original  $\varphi(p)$ , which we shall designate by  $\Phi(t)$

([1] page 283), i. e., let

$$\varphi(p) = p \int_0^{\infty} \Phi(t) e^{-pt} dt \quad (2)$$

Replacing  $p$  by  $t$  in this equality we substitute expression  $\varphi(t)$  in formula

(1):

$$F(p) = p \int_0^{\infty} h(t) t e^{-pt} dt \int_0^{\infty} \Phi(t) e^{-t^2} dt$$

In the second integral we shall replace variable  $u = t + p$  and change the order of integration; then we shall obtain

$$F(p) = p \int_0^{\infty} \Phi(u-p) du \int_0^{\infty} h(t) t e^{-tu} dt$$

Let  $H(p) \div h(t)$ , then

$$\left[ \frac{H(u)}{u} \right] = - \int_0^{\infty} h(t) t e^{-ut} dt \quad (3)$$

consequently, finally we shall obtain such a formula:

$$F(p) = -p \int_0^{\infty} \Phi(u-p) \left[ \frac{H(u)}{u} \right]' du \quad (4)$$

From formula (4) we can obtain an expression of the integral from the product of two functions. Indeed, we have, obviously, the equality

$$\frac{F(p)}{p} = \int_0^{\infty} \varphi(t) h(t) dt = \int_0^{\infty} \Phi(u) \left[ \frac{H(u)}{u} \right]' du \quad (5)$$

Formula (4) is easily generalized in the case of the product of three and more numbers of functions. Let, for example

$$f(t) = \varphi(t) \varphi_1(t) h(t) \\ F(p) = f(t), \varphi(p) = \Phi(t), \varphi_1(t) = \Phi_1(t)$$

Then, analogous to the preceding, we shall write

$$F(p) = p \int_0^{\infty} h(t) \varphi_1(t) \varphi(t) e^{-pt} dt = \\ = p \int_0^{\infty} h(t) dt \int_0^{\infty} \Phi_1(x) e^{-xt} dx \int_0^{\infty} \Phi(u) e^{-u(t+p)} du$$

Replace the variable in the third integral  $u = v + p$ , then change the order of integration, after which it is possible to write

$$F(p) = p \int_0^{\infty} \Phi(u-p) du \int_0^{\infty} h(t) dt \int_0^{\infty} \Phi_1(x) e^{-xt+u} dx$$

In the last integral we make the following replacement of the variable integration: ( $v = u + x$ ) then we shall change the order of integration. After that

$$F(p) = p \int_0^{\infty} \Phi(u-p) du \int_0^{\infty} \Phi_1(v-u) dv \int_0^{\infty} h(t) e^{-vt} dt$$

Finally, let us note that

$$\int_0^{\infty} h(t) e^{-vt} dt = \left[ \frac{H(v)}{v} \right]' = H(p) = h(t)$$

Thus, we obtain a formula representing the product of three originals:

$$F(p) = p \int_0^{\infty} \Phi(u-p) du \int_0^{\infty} \Phi_1(v-u) \left[ \frac{H(v)}{v} \right]' dv \quad (7)$$

Submitted  
19 May 1946

### Literature

1. B. Van der Pol' and H. Bremmer. Operation calculus on the basis of a bilateral Laplace transform. Foreign Literature Publishing House, 1952.



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